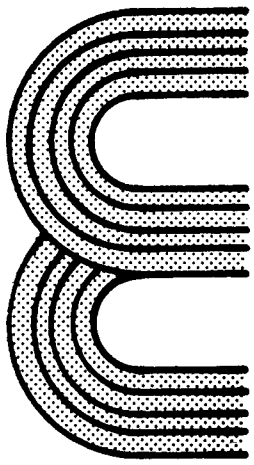

Basewide Energy Systems Plan

Executive Summary

Final Report

Fort Knox, Kentucky

June 1980

Prepared For

MOBILE DISTRICT CORPS OF ENGINEERS
MOBILE, ALABAMA
CONTRACT DACA01-77-C-0094

Prepared By

BLACK & VEATCH
CONSULTING ENGINEERS
KANSAS CITY, MISSOURI

B-2

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BASEWIDE ENERGY SYSTEMS PLAN

EXECUTIVE SUMMARY
FINAL REPORT

FORT KNOX, KENTUCKY

MOBILE DISTRICT

CORPS OF ENGINEERS

MOBILE, ALABAMA

BLACK & VEATCH

CONSULTING ENGINEERS

KANSAS CITY, MISSOURI

CONTRACT DACA01-77-C-0094
JUNE 1980

EXECUTIVE SUMMARY

This is a summary of the results of the Basewide Energy Systems Plan for Fort Knox, Kentucky. This plan includes analyses and recommendations of energy conservation projects for reduction of the installation's present energy consumption. The installation should be aware that savings figures presented in this summary can only be realized after all projects have been implemented. Black & Veatch has developed projects that would meet the funding requirements for the energy conservation program. Furthermore, the recommended projects provide partial compliance with the energy conservation requirement for the installation as outlined in the Army Facilities Energy Plan. This summary presents data on the following:

- Existing energy consumption
- Source energy reductions due to energy conservation techniques for buildings and their systems
- Application of solar energy to reduce fossil fuel consumption
- Savings utilizing central energy monitoring and control systems (EMCS)
- Use of solid waste as an alternate energy source
- Analysis of Total Energy/Selective Energy (TE/SE) systems

Tables 1 and 2 present information pertaining to the physical descriptions and energy consumption of 51 typical buildings used to verify historical energy consumption in the development of the basewide

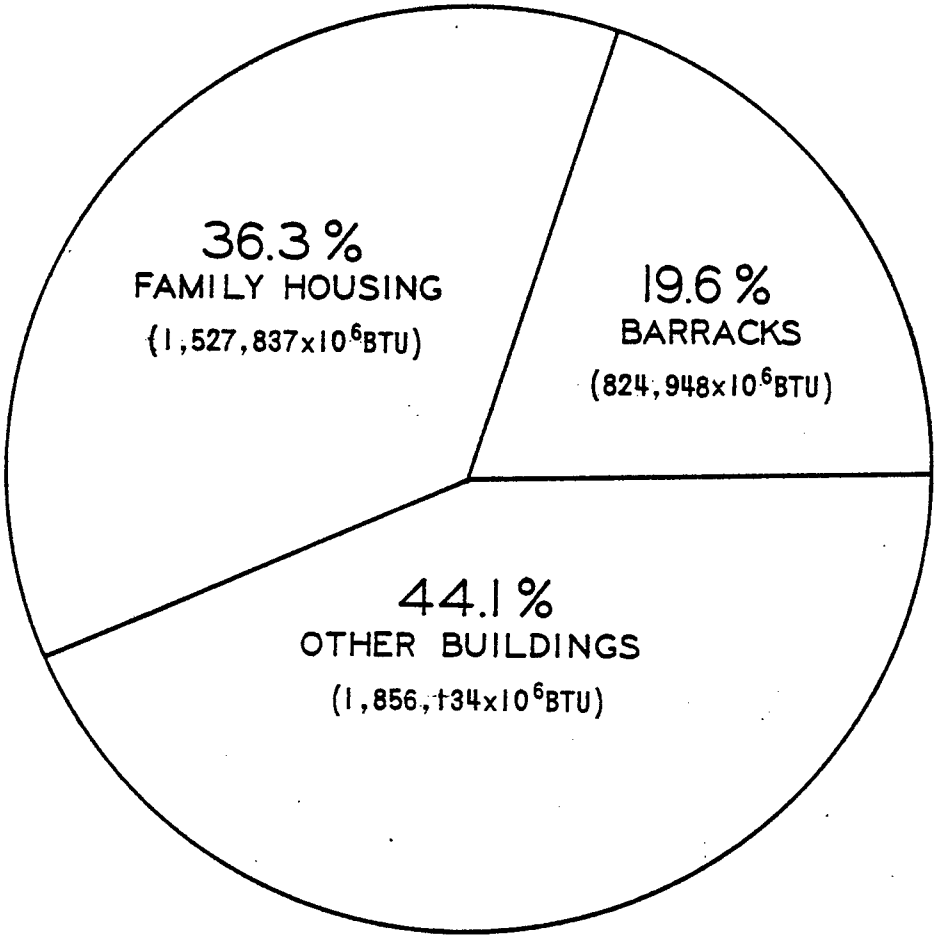
energy use model. This model was then utilized as the foundation for energy conservation project analyses and recommendations. Table 3 summarizes the daily personnel occupancy for each typical building. Tables 1, 2 and 3 also provide information which may be used to estimate source energy consumption for similar buildings within the designated groupings (see Appendix A for all tables referenced in this report). The estimated annual source energy consumption for all building types contributing to the basewide annual total of 4,208,920 mega-Btu consumed during base year 1975, is shown on Figure 1.

Table 4 indicates the annual source energy consumed by each of the significant building groups used in our basewide energy model. The model was within 10 percent of the historical source energy consumption for FY 1978 shown below.

Yearly Source Energy Consumption in Btu x 10^6

	1978
Electricity	1,511,863
Natural Gas	2,085,793
Propane Gas	791
Fuel Oil No. 2	491,813
Coal	36,895
TOTAL	4,127,155

The total estimated source energy savings due to implementation of all feasible energy conservation projects developed within the scope of this study is 782,633 mega-Btu/year. These projects consisted of various



CONSUMPTION FOR FY'75

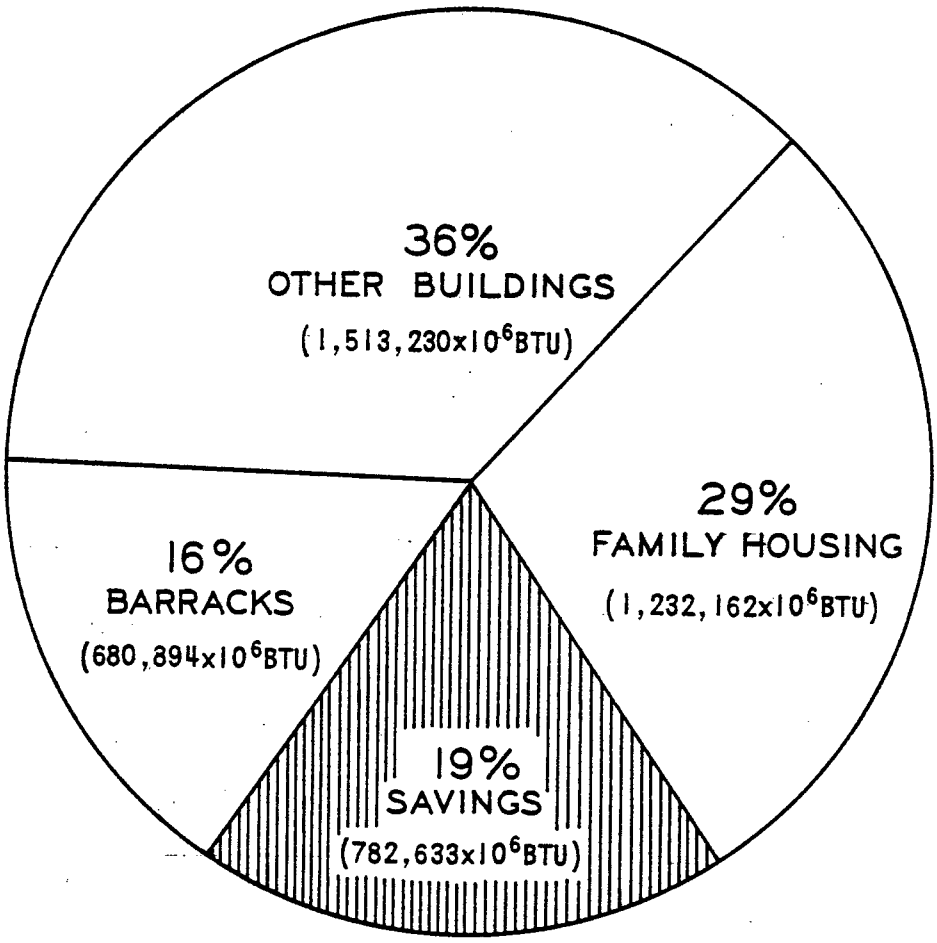
(4,208,920x10⁶BTU)

FIGURE 1

architectural improvements, and mechanical and electrical system modifications. Refer to Appendix B of this summary for lists of all projects investigated. The lists also provide comments that explain briefly Black & Veatch's action or recommendation.

Table 5 lists the project number, percent of basewide reduction, and the source energy savings for the indicated building types. Figure 2 illustrates the combined effect of the recommended energy saving improvements, as compared to the FY 1975 source energy expenditure. Our estimates indicate a savings of approximately 19 percent over the base year (1975). Figure 3 illustrates the relative percent reduction for significant building groups comprising the 782,633 mega-Btu/year.

A detailed analysis of the projects listed in Table 5 is included in the following reports. Further explanation of the historical energy consumption, basewide energy model, and energy conservation analysis, can be found in the Energy Use Survey. Utilizing solar energy, a renewable energy source, to reduce Ft. Knox's dependence on nonrenewable energy sources revealed that the projects investigated would be economically impracticable. Seven concepts were evaluated and are presented in the Solar Energy Applications and Evaluations. The Energy Monitoring and Control Systems (EMCS) study includes recommendations for an extension of the existing system and the utilization of an FM control system. An extension of the existing system would result in a savings of 64,833 mega-Btu/year, while the FM control system would save 50,412 mega-Btu/ year. Assistance was given in evaluating the use of solid



CONSUMPTION AFTER ENERGY CONSERVATION PROJECTS

(3,426,287x10⁶BTU)

FIGURE 2

ALLOCATION OF ENERGY CONSERVATION PROJECTS SAVINGS

FOR SIGNIFICANT BUILDING GROUPS

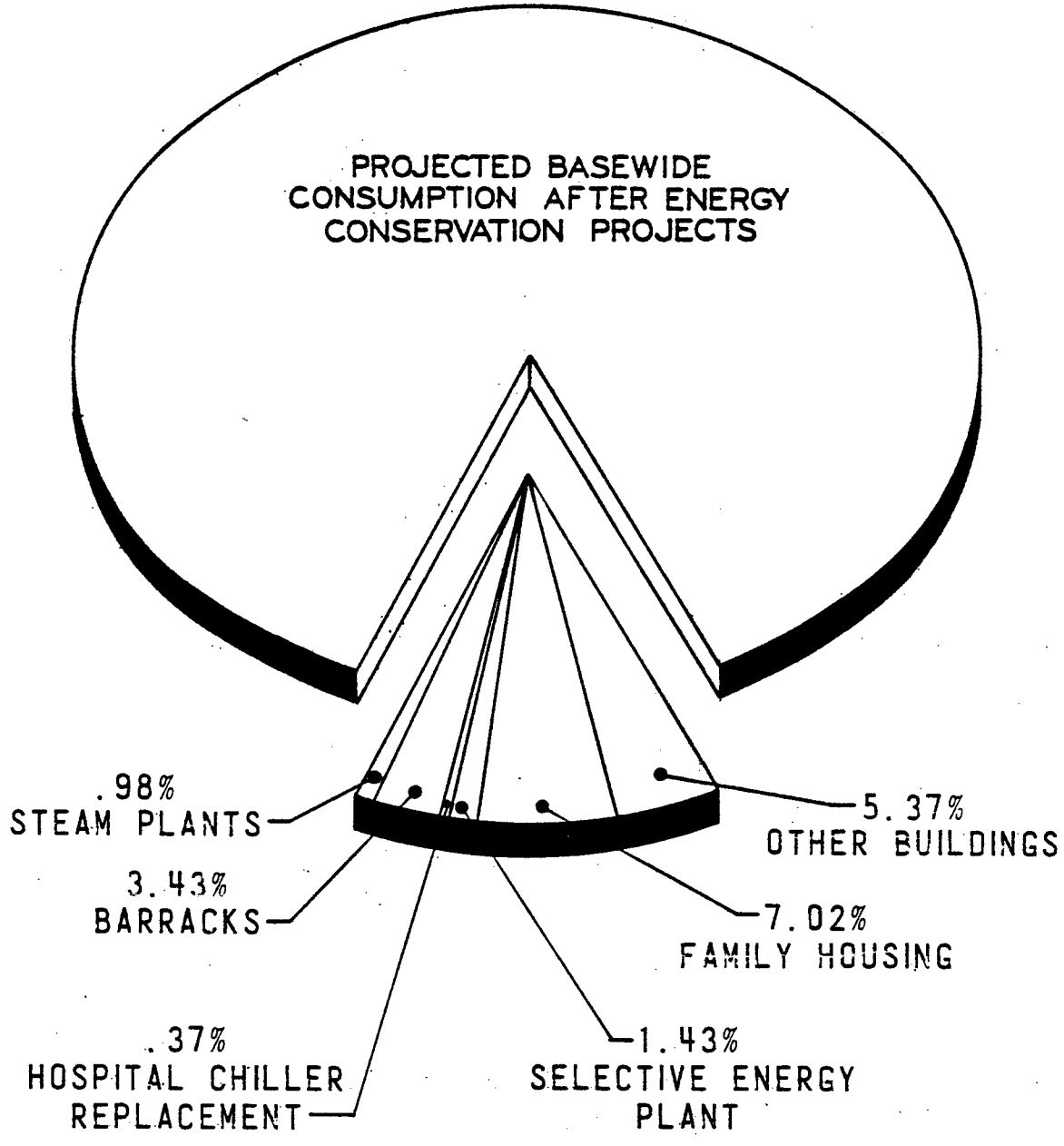


FIGURE 3

waste for reducing source energy consumption at Fort Knox. This project, recommended by others, provides for the installation of a solid waste-burning incinerator facility to supply steam to one of the existing steam distribution systems. This facility, which is presently under design, was found to be in accordance with similar facilities recommended by us at other Mobile District COE bases.

The incorporation of a total energy system at this installation would not be recommended. However it is recommended that a selective energy plant with electric peak shaving capability be constructed. This SE plant would save 1.4 percent of source energy used while basewide reduction in natural gas and fuel oil would amount to 37 percent. The plant would also be capable of generating 38 percent of the basewide electric power requirement and would shave 58 percent of the annual electric peak. Detailed descriptions of the TE/SE systems analyzed are included in the report entitled Total Energy, Selective Energy, and Central Boiler Plants.

Table 6 was developed to give a prioritized schedule, in order of fiscal year, for implementing the recommended energy conservation projects. Figure 4 was ultimately devised to illustrate Fort Knox's projected source energy use through 1986. The figure includes both the effect of the source energy reduction due to the implementation of the recommended projects by fiscal year and the energy increase based on projected population figures found in the Energy Use Survey. Figure 5 indicates the impact of increasing energy costs and the reduction of those costs

PROJECTED ENERGY CONSUMPTION - FORT KNOX, KENTUCKY

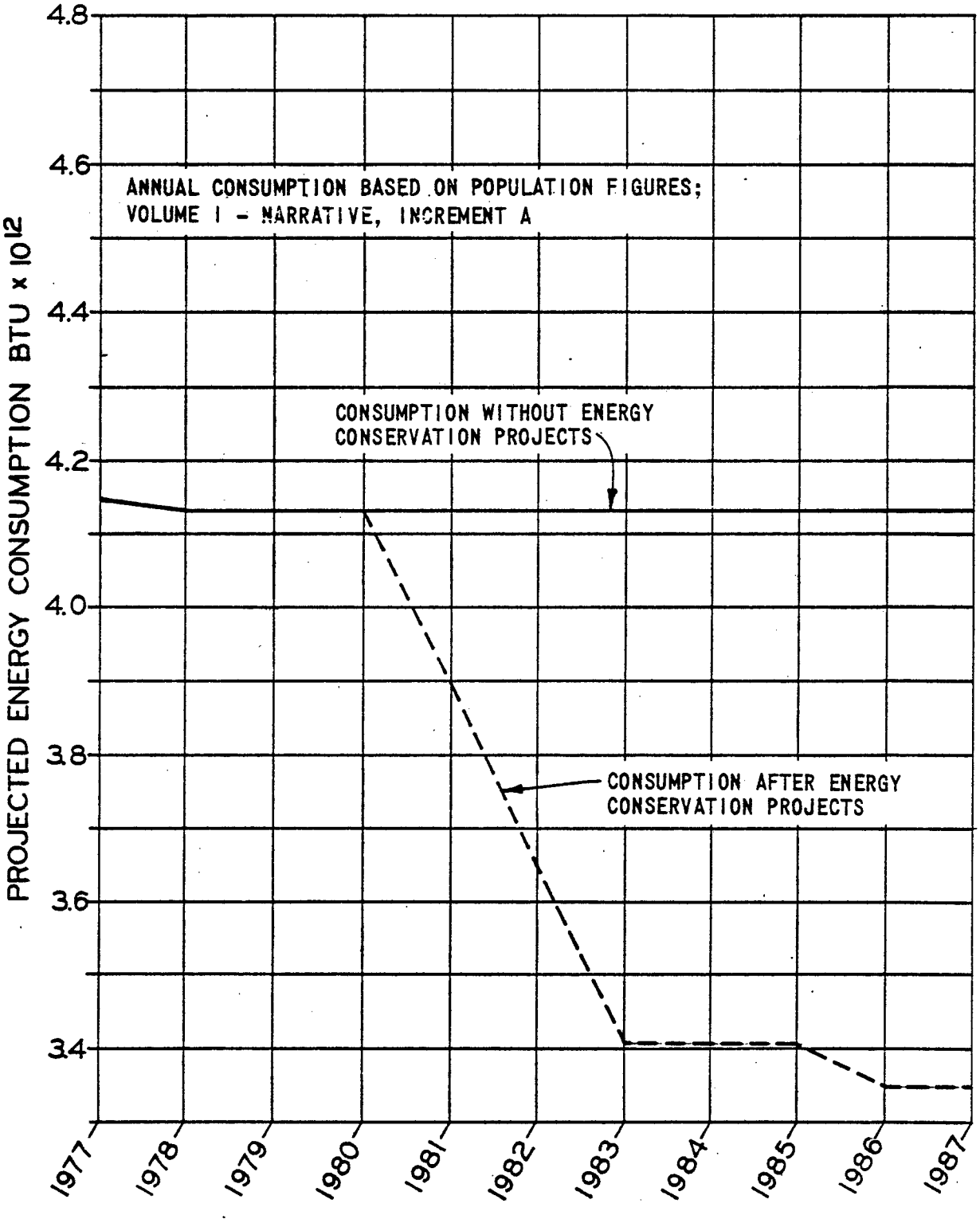


FIGURE 4

Fk

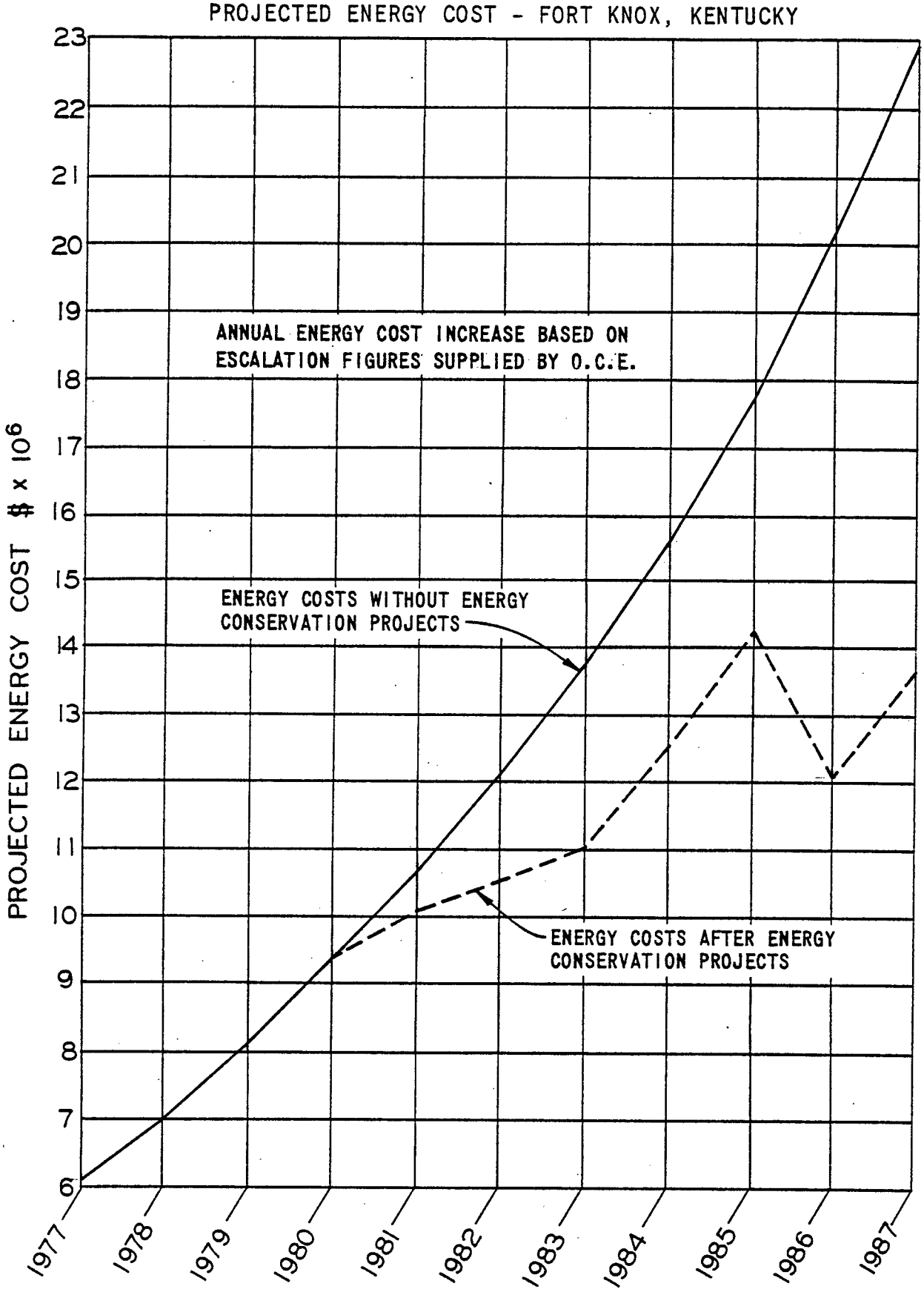

PROJECTED ENERGY COST - FORT KNOX, KENTUCKY
PROJECTED ENERGY COST $ x 10^6
23
22
21
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
ANNUAL ENERGY COST INCREASE BASED ON ESCALATION FIGURES SUPPLIED BY O.C.E.
ENERGY COSTS WITHOUT ENERGY CONSERVATION PROJECTS
ENERGY COSTS AFTER ENERGY CONSERVATION PROJECTS
1977
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987

FIGURE 5

after the implementation of projects listed in Table 6. The energy costs were escalated using the rates supplied by the Office of the Chief of Engineers in the volume entitled Energy Conservation Investment Program Guidance.

APPENDIX A

TABLES

TABLE I
TYPICAL BUILDING CONSTRUCTION DATA
FORT KNOX

GROUP NO.	BLDG.	BUILDING DESCRIPTION	NO. FLS	CONSTRUCTION					"U" VALUES					WINDOW SQ. FT.	AREA (FT.²)	COOLING		HEATING		PEAK TRNS LOAD MBH		DOMESTIC HOT WATER	
				ROOF	WALL	FLOOR	WINDOW	DOOR	ROOF	WALL	FLOOR	WINDOW	DOOR			SYSTEM	CAP. (TONS)	SYSTEM	FUEL	GAIN	LOSS	CAP. (G)	FUEL
A-1	5932	ADMINISTRATION & STORAGE	1	BUILT-UP	BRICK ON CONC. FRAME	SLAB ON GRADE	STORM CLEAR GLASS	METAL HOLLOW CORE	.1¾ .18	.30	–	1.13 1.06	.55	682	11867	CHILLER	17	B.P. 5943	STEAM TO HW	¾2.0	281.5	75	GAS
A-2	2382	COMMAND BUILDING	2	BUILT-UP	CONC. BLOCK	SLAB ON GRADE	SINGLE CLEAR GLASS	METAL	.06	.¾7	–	1.13 1.06	.55	8¾0	8¾85	NONE	–	B.P. 2380	STEAM TO HW	–	227.8	75	STEAM
A-3	6715	ADMINISTRATIVE	2	COMPOSITE SHINGLE	CLAPBOARD ON WOOD FRAME	TILE, VENTED CRAWL SPACE	SINGLE CLEAR GLASS	WOOD SOLID CORE	.05	.36	.5¾	1.13 1.06	.¾9 .¾7	260	3200	NONE	–	BOILER	GAS	–	251.3	30	GAS
AH-1	5253	HANGAR	1	BUILT-UP	CONCRETE	SLAB ON GRADE	SINGLE CLEAR GLASS	METAL	.0¾	.58	–	1.13 1.06	.¾9 .¾7	2193	18905	WINDOW UNITS	2	B.P. 5213	STEAM TO HW	22.2	588.7	NONE	–
B-1	6011	BARRACKS	3	BUILT-UP	BRICK ON CONC. FRAME	SLAB ON GRADE	SINGLE CLEAR GLASS	STEEL HOLLOW CORE	.0¾	.29	–	1.13 1.06	.55	¾086	¾0650	CHILLER	75	B.P. 5943	STEAM TO HW	188.6	920.0	2100	GAS
B-2	6557	BARRACKS	3	BUILT-UP	CONC. BLOCK	TILE, BASEMENT	SINGLE CLEAR GLASS	WOOD SOLID CORE	.06	.13	.5¾	1.13 1.06	.¾9 .¾7	5834	39¾7¾	NONE	–	BOILER	OIL	–	648.7	250	STEAM
B-3	7306	BARRACKS	2	COMPOSITE SHINGLE	CLAPBOARD ON WOOD FRAME	TILE, VENTED CRAWL SPACE	SINGLE CLEAR GLASS	WOOD SOLID CORE	.32	.36	.5¾	1.13 1.06	.¾9 .¾7	608	¾720	NONE	–	BOILER	GAS	–	129.¾	85	GAS
B-¾	2607	BOQ	3	BUILT-UP	CONC. BLOCK	SLAB ON GRADE	SINGLE CLEAR GLASS	METAL HOLLOW CORE	.16	.11	–	1.13 1.06	.55	1920	23¾23	THRU WALL	¾0	UNIT HEATERS	ELEC	73.2	339.6	60	ELEC
CS-1	1173	CHAPEL	1	COMPOSITE SHINGLE	BRICK	WOOD, ENCL. CRAWL SPACE	SINGLE STAINED GLASS	WOOD SOLID CORE	.26	.17	.19	1.13 1.06	.¾9 .¾7	698	6386	CHILLER	30	BOILER	GAS	87.¾	227.7	NONE	–
CS-2	5007	CHAPEL	1	COMPOSITE SHINGLE	CLAPBOARD ON WOOD FRAME	WOOD, ENCL. CRAWL SPACE	SINGLE STAINED GLASS	WOOD SOLID CORE	.3¾	.26	.19	1.13 1.06	.¾9 .¾7	¾11	3765	NONE	–	BOILER	GAS	–	171.1	¾0	GAS
CS-3	¾55¾	MUSEUM	2	BUILT-UP	CONCRETE	SLAB ON GRADE	NONE	METAL HOLLOW CORE	.2	.5	–	–	.55	–	23131	CHILLER	90	BOILER	GAS	¾8.3	222.7	30	GAS
CS-¾	0126	CAFETERIA	1	BUILT-UP	MASONRY BLOCK	SLAB ON GRADE	SINGLE TINTED GLASS	METAL HOLLOW CORE	.17	.19	–	1.13 1.06	.55	1263	16200	CHILLER	275	BOILER	OIL	56.6	325.3	85	GAS
CS-5	2320	POST EXCHANGE	2	COMPOSITE SHINGLE	CONC. BLOCK	SLAB ON GRADE	SINGLE CLEAR GLASS	METAL HOLLOW CORE	.058	.36	–	1.13 1.06	.55	610	7180	COND. UNIT	20	BOILER	GAS	39.1	169.8	¾0	GAS
CS-6	1383	POST HOUSING ADMINISTRATION	2	COMPOSITE SHINGLE	CONC. BLOCK	CONC., BASEMENT	SINGLE CLEAR GLASS	METAL	.3	.5	.5	1.13 1.06	.55	621	7336	WINDOW UNIT	15	UNIT HTRS BOILER	GAS GAS	1.¾	149.2	¾0	GAS
CS-7	7320	CERAMIC SHOP	1	COMPOSITE SHINGLE	CLAPBOARD ON WOOD FRAME	SLAB ON GRADE	SINGLE CLEAR GLASS	WOOD SOLID CORE	.30	.36	–	1.13 1.06	.¾9 .¾7	¾90	7200	NONE	–	BOILER	GAS	–	270.8	30	GAS
CS-8	1227	COMMUNICATIONS SYSTEM BLDG.	2	BUILT-UP	CONC. BLOCK	TILE, BASEMENT	SINGLE CLEAR GLASS	WOOD SOLID CORE	.15	.35	.5¾	1.13 1.06	.¾9 .¾7	1081	24129	CHILLER	33	BOILER	GAS	74.6	234.3	70	GAS
CS-9	850	GYMNASIUM	1	BUILT-UP	BRICK ON STEEL FRAME	SLAB ON GRADE	SINGLE CLEAR GLASS	WOOD SOLID CORE	.12	.2	–	1.13 1.06	.¾9 .¾7	128	33188	NONE	–	B.P. 852	STEAM	–	1395.6	60	STEAM
CS-11	2385	BOWLING ALLEY	1	BUILT-UP	CONC. BLOCK & BRICK	SLAB ON GRADE	NONE	METAL HOLLOW CORE	.21	.32	–	–	.55	–	22351	CHILLER	55	BOILER	GAS	104.9	334.8	¾0	GAS
CS-12	7060	THEATER	1	BUILT-UP	ASBESTOS BOARD	SLAB ON GRADE	SINGLE CLEAR GLASS	WOOD SOLID CORE	.2	.3	–	1.13 1.06	.¾9 .¾7	1266	12891	CHILLER	13	BOILER	GAS	8¾.1	380.2	NONE	–
CS-13	5223	FIRE STATION	1	BUILT-UP	CONC. BLOCK & BRICK	SLAB ON GRADE	SINGLE CLEAR GLASS	METAL HOLLOW CORE	.2	.3	–	1.13 1.06	.55	252	¾292	NONE	–	B.P. 5213	STEAM TO HW		171.8	30	GAS
CW-1	1198	COLD STORAGE WAREHOUSE	1	BUILT-UP	CONC. BLOCK & STUCCO	SLAB ON GRADE	SINGLE CLEAR GLASS	WOOD INSULATED ¾"	.2	.3	–	1.13 1.06	.3	72	26085	WINDOW UNIT	5	UNIT HEATERS	GAS	17.1	27.¾	30	GAS
D-1	5942	MESS HALL	1	BUILT-UP	BRICK ON CMU	CONC. CRAWL SPACE	SINGLE CLEAR GLASS	WOOD & STEEL	.2	.3	.5	1.13 1.06	.¾9 .55	1167	13280	CHILLER	75	B.P. 5943	STEAM	19.6	187.3	1000	GAS
D-3	6723	MESS HALL	1	COMPOSITE SHINGLE	CLAPBOARD ON WOOD FRAME	TILE, OPEN CRAWL SPACE	SINGLE CLEAR GLASS	WOOD	.30	.23	.38	1.13 1.06	.¾6 .¾5	¾¾6	2892	NONE	–	BOILER	GAS	148.¾	148.¾	86	GAS
FH-2	¾32	FAMILY HOUSING	2	SLATE	BRICK	TILE, WOOD	SINGLE CLEAR GLASS	WOOD SOLID CORE	.0¾	.32	.¾3 .3¾	1.13 1.06	.¾9 .¾7	385	¾508	*	7	BOILER	GAS	7.6	86.1	¾0	GAS
FH-3	¾¾08	FAMILY HOUSING	1	COMPOSITE SHINGLE	BRICK	WOOD, VENTED CRAWL SPACE	SINGLE CLEAR GLASS	WOOD SOLID CORE	.07	.20	.36	1.13 1.06	.¾9 .¾7	38¾	3728	NONE	–	FURNACE	GAS	–	105.5	30	GAS
FH-¾	75¾3	FAMILY HOUSING	1	COMPOSITE SHINGLE	CLAPBOARD ON WOOD FRAME	SLAB ON GRADE	SINGLE CLEAR GLASS	WOOD SOLID CORE	.05	.22	–	1.13 1.06	.¾9 .¾7	39¾	3042	NONE	–	FURNACE	GAS	–	77.2	¾0	GAS

*CALCULATIONS WERE BASED ON A PERCENTAGE OF THE GROUP HAVING AIR CONDITIONING

TABLE I (CONT'D)
TYPICAL BUILDING CONSTRUCTION DATA
FORT KNOX

GROUP NO.	BLDG.	BUILDING DESCRIPTION	NO. FLS	CONSTRUCTION					"U" VALUES					WINDOW SQ. FT:	AREA (FT.2)	COOLING		HEATING		PEAK TRNS LOAD MBH		DOMESTIC HOT WATER	
				ROOF	WALL	FLOOR	WINDOW	DOOR	ROOF	WALL	FLOOR	WINDOW	DOOR			SYSTEM	CAP. (TONS)	SYSTEM	FUEL	GAIN	LOSS	CAP. (G)	FUEL
FH-5	5683	FAMILY HOUSING	1	PITCH & GRAVEL	ASBESTOS & FACE BRICK	SLAB ON GRADE	SINGLE CLEAR GLASS	WOOD & WOOD STORM	.07	.29 .27	–	1.13 1.06	.27	409	3121	*	1	FURNACE	GAS	1.0	86.4	40	GAS
FH-6	1445	FAMILY HOUSING	2	SLATE SHINGLE	BRICK	WOOD	SINGLE CLEAR GLASS	WOOD SOLID CORE	.06	.17	.07	1.13 1.06	.49 .47	406	6541	*	4	BOILER	GAS	11.2	81.2	50	GAS
FH-7	4634	FAMILY HOUSING	2	COMPOSITE SHINGLE	BRICK	SLAB ON GRADE	SINGLE CLEAR GLASS	WOOD STORMS	.08	.2	–	1.13 1.06	.33	652	5682	*	1	FURNACE	GAS	5.6	147.1	30	GAS
FH-8	5307	FAMILY HOUSING	2	SHEATHING	BRICK & WOOD	TILE	SINGLE CLEAR GLASS	WOOD SOLID CORE	.14	.35 .37	.27	1.13 1.06	.49 .47	802	10624	*	1	FURNACE	GAS	5.2	336.1	40	GAS
FH-9	4101	FAMILY HOUSING	2	COMPOSITE SHINGLE	CLAPBOARD ON WOOD FRAME	WOOD BASEMENT	SINGLE CLEAR GLASS	WOOD SOLID CORE	.27	.19	.07	1.13 1.06	.49 .47	109	2525	*	1	FURNACE	GAS	.6	57.1	30	GAS
L-1	0018	LAUNDRY	1	COMPOSITE SHINGLE	ASBESTOS ON WOOD FRAME	SLAB ON GRADE	SINGLE CLEAR GLASS	WOOD	.3	.3	–	1.13 1.06	.49 .47	2400	49823	NONE	–	B.P. 16	STEAM	–	1208.0	40	STEAM
LA-1	1068	ANIMAL HOLDING CENTER	1	BUILT-UP	CONC. BLOCK	BASEMENT	SINGLE CLEAR GLASS	STEEL HOLLOW CORE	.08	.36	.54	1.13 1.06	.55	43	5080	COND. UNITS	17	BOILER	GAS	24.7	89.0	75	GAS
M-1	2000	DENTAL CLINIC	1	BUILT-UP	BRICK ON CONC. BLOCK	TILE ON CONC. ENCL. CRL. SP.	SINGLE CLEAR GLASS	METAL ALUMINUM	.11	.32	.54	1.13 1.06	.55	1076	10840	CHILLER	40	BOILER	GAS	60.3	299.4	75	GAS
M-2	6440	DISPENSARY	1	COMPOSITE SHINGLE	CLAPBOARD ON WOOD FRAME	TILE	SINGLE CLEAR GLASS	WOOD	.26	.23	.23	1.13 1.06	.49 .47	288	2196	NONE	–	FURNACE	GAS	–	147.2	30	GAS
MA-1	2783	INSTRUMENT & SMALL ARMS REPAIR	1	BUILT-UP	CONC. BLOCK	BASEMENT	SINGLE CLEAR GLASS	STEEL HOLLOW CORE	.05	.32	.54	1.13 1.06	.55	527	21401	REMOTE COND.	30	B.P. 2770	STEAM	38.1	299.7	75	GAS
MA-2	6117	TANK MAINTENANCE	1	BUILT-UP	CONC. BLOCK & METAL	SLAB ON GRADE	SINGLE CLEAR GLASS	METAL INSULATED	.27	.51 .11	–	1.13 1.06	.47 .46	1429	7421	NONE	–	BOILER	OIL GAS	–	280.4	94	STEAM
MA-3	7347	MAINTENANCE	1	COMPOSITE SHINGLE	CLAPBOARD ON WOOD FRAME	SLAB ON GRADE	SINGLE CLEAR GLASS	WOOD SOLID CORE	.44	.27	–	1.13 1.06	.49 .47	231	3108	NONE	–	BOILER	GAS	–	115.1	NONE	
S-1	5101	DATA PROCESSING & CHILDCARE	2	TILE BUILT-UP	BRICK ON CONC. BLOCK	TILE	SINGLE CLEAR GLASS	METAL	.32 .31	.23	.24	1.13 1.06	.55	2142	35158	CHILLER	65	BOILER	GAS	95.8	469.5	50	GAS
T-1	6014	CLASSROOM & HEADQUARTERS	1	BUILT-UP	BRICK ON CONC. BLOCK	SLAB ON GRADE	SINGLE CLEAR GLASS	METAL	.11	.32	–	1.13 1.06	.55	1133	5534	COND.	44	HOT WATER	HW	52.7	198.9	30	GAS
T-2	9298	CLASSROOM	1	BUILT-UP	CONC. BLOCK	SLAB ON GRADE	WIRE GLASS	METAL HOLLOW CORE	.17 .05	.5	–	1.13 1.06	.55	352	10800	NONE	–	FURNACES	OIL	–	499.4	50	OIL
T-3	1543	VEHICLE TRAINING	1	COMPOSITE SHINGLE	CLAPBOARD ON WOOD FRAME	SLAB ON GRADE	SINGLE CLEAR GLASS	WOOD	.3	.27	–	1.13 1.06	.49 .47	460	7912	NONE	–	BOILER	OIL	–	164.3	NONE	–
U-1	ALL OF GROUP	WASTE WATER TREATMENT	◄						NOT APPLICABLE														►
U-2	ALL OF GROUP	WATER TREATMENT	◄						NOT APPLICABLE														►
U-3	4208	PUMP HOUSES	◄						NOT APPLICABLE					►	753	◄		NOT APPLICABLE					►
U-4	0017	BOILER PLANT	1	CORRUGATED ASBESTOS	CORR. ASBESTOS ON STEEL FRAME	SLAB ON GRADE	SINGLE CLEAR GLASS	METAL	1.18	1.18	–	1.13 1.06	.55	468	5082	NONE	–	BOILER	GAS OIL	–	21.4	90	ELEC
W-1	6569	CLOTHING & TEXTILE REPAIR	1	BUILT-UP	CONC. BLOCK	CONC. FLOOR	SINGLE CLEAR GLASS	WOOD SOLID CORE	.15	.53	–	1.13 1.06	.49 .47	1140	40000	PACKAGE UNIT	5	BOILER	GAS	79.7	758.6	52	ELEC
W-2	2931	WAREHOUSE	1	COMPOSITE SHINGLE	CLAPBOARD ON WOOD FRAME	SLAB ON GRADE	SINGLE CLEAR GLASS	WOOD SOLID CORE	.26	.36	–	1.13 1.06	.49 .47	125	1296	NONE	–	FURNACE	GAS	–	56.0	NONE	–
W-3	6570	WAREHOUSE	1	BUILT-UP	CONC. BLOCK	SLAB ON GRADE	SINGLE CLEAR GLASS	WOOD	.2	.5	–	1.13 1.06	.49 .47	64	8000	NONE	–	BOILER	GAS	–	817.5	50	GAS
X		NO UTILITIES	◄						NOT APPLICABLE														►
Z		ELECTRIC ONLY (INCLUDES ELECTRIC AUXILIARIES & OUTDOOR LIGHTING	◄						NOT APPLICABLE														►

*CALCULATIONS WERE BASED ON A PERCENTAGE OF THE GROUP HAVING AIR CONDITIONING

TABLE 2
TYPICAL BUILDING ENERGY CONSUMPTION DATA
FORT KNOX

GROUP NO.	BLDG.	BUILDING DESCRIPTION	ANNUAL ENERGY SOURCE CONSUMPTION BTUx10^6			ELEC'_ ENER. CONSUMPTION		BTU x 10^3 / FT^2
			FUEL	ELEC.	TOTAL	KW PEAK	KWH/YR	
A-1	5932	ADMINISTRATION & STORAGE	649	671	1298	40	53170	109.4
A-2	2382	COMMAND BUILDING	434	1581	2015	32	136310	237.5
A-3	6715	ADMINISTRATIVE	546	265	811	10	22810	253.4
AH-1	5253	HANGAR	1376	422	1798	17	36386	95.1
B-1	6011	BARRACKS	5820	2853	8673	134	245947	213.4
B-2	6557	BARRACKS	4582	4430	9012	86	381870	228.3
B-3	7306	BARRACKS	926	153	1079	4	12110	228.6
B-4	2607	BOQ	0	4655	4655	260	401282	198.7
CS-1	1173	CHAPEL	342	966	1308	76	83258	204.8
CS-2	5007	CHAPEL	1106	147	1253	5	12670	332.8
CS-3	4554	MUSEUM	1488	1051	2539	125	90618	109.8
CS-4	0126	CAFETERIA	4067	6506	10573	326	560897	652.7
CS-5	2320	POST EXCHANGE	503	335	838	37	28883	116.7
CS-6	1383	POST HOUSING ADMINISTRATION	280	898	1178	15	77441	160.6
CS-7	7320	CERAMIC SHOP	930	95	1025	6	8200	142.4
CS-8	1227	COMMUNICATIONS SYSTEM BLDG.	141	20987	21128	472	1089237	875.6
CS-9	850	GYMNASIUM	5701	615	6316	22	53020	190.3
CS-11	2385	BOWLING ALLEY	1151	4112	5263	215	354497	235.5
CS-12	7060	THEATER	949	752	1701	86	64810	132.0
CS-13	5223	FIRE STATION	612	346	958	10	29800	223.2
CW-1	1198	COLD STORAGE WAREHOUSE	214	496	710	15	42780	27.3
D-1	5942	MESS HALL	11394	7801	19195	220	672480	1445.4
D-3	6723	MESS HALL	2399	126	2525	4	10830	873.1
FH-2	432	FAMILY HOUSING	175	45	220	8	3867	48.8
FH-3	4408	FAMILY HOUSING	832	89	921	6	7630	247.0
FH-4	7543	FAMILY HOUSING	542	143	685	3	12340	225.2

TABLE 2 (CONT'D)
TYPICAL BUILDING ENERGY CONSUMPTION DATA
FORT KNOX

GROUP NO.	BLDG.	BUILDING DESCRIPTION	ANNUAL ENERGY SOURCE CONSUMPTION BTU x 10^6			ELEC'L ENER. CONSUMPTION		BTU x 10^3 / FT^2
			FUEL	ELEC.	TOTAL	KW PEAK	KWH/YR	
FH-5	5683	FAMILY HOUSING	1003	191	1194	3	16478	382.6
FH-6	1445	FAMILY HOUSING	599	755	1354	18	65120	207.0
FH-7	4634	FAMILY HOUSING	1153	311	1464	8	26780	257.7
FH-8	5307	FAMILY HOUSING	2260	653	2913	13	56310	274.2
FH-9	4101	FAMILY HOUSING	394	71	465	11	6146	184.2
L-1	0018	LAUNDRY	27762	1495	29257	87	128880	587.2
LA-1	1068	ANIMAL HOLDING CENTER	164	611	775	24	52669	152.6
M-1	2000	DENTAL CLINIC	1186	1045	2231	85	90092	205.8
M-2	640	DISPENSARY	322	65	387	2	5570	176.2
MA-1	2783	INSTRUMENT & SMALL ARMS REPAIR	2028	2501	4529	122	215620	211.6
MA-2	6117	TANK MAINTENANCE	648	528	1176	14	45480	158.5
MA-3	7347	MAINTENANCE	332	118	450	4	10130	144.8
S-1	5101	DATA PROCESSING & CHILDCARE	2190	4855	7045	166	418500	200.4
T-1	6014	CLASSROOM & HEADQUARTERS	503	605	1108	54	52161	200.2
T-2	9298	CLASSROOM	1134	701	1836	16	60470	170.0
T-3	1543	VEHICLE TRAINING	411	104	515	5	9000	65.1
U-1	ALL OF GROUP	WASTE WATER TREATMENT	←		N/A			→
U-2	ALL OF GROUP	WATER TREATMENT	←		N/A			→
U-3	4208	PUMP HOUSES	0	9443	9443	109	814080	12540.5
U-4	0017	BOILER PLANT	32	283	315	5	24410	117.2
W-1	6569	CLOTHING & TEXTILE REPAIR	2284	2146	4430	166	185032	110.8
W-2	2931	WAREHOUSE	86	103	189	3	8920	145.8
W-3	6570	WAREHOUSE	1384	2423	3807	4.29	208870	475.9
X		NO UTILITIES	←		N/A			→
Z		ELECTRIC ONLY	0	70903	70903	N/A	6112310	N/A

TABLE 3
BUILDING OCCUPANCY
FORT KNOX

GROUP NO.	BLDG	BUILDING DESCRIPTION	NORMAL PEAK POPULATION	OCCUPANCY
A-1	5932	ADMINISTRATION & STORAGE	67	7:00 A.M. TO 4:30 P.M. - WEEKDAYS
A-2	2382	COMMAND BUILDING	80	6:30 A.M. TO 5:30 P.M. - WEEKDAYS
A-3	6715	ADMINISTRATIVE	6715	6:30 A.M. TO 4:30 P.M. - WEEKDAYS
AH-1	5253	HANGAR	110	OPEN 24 HOURS
B-1	6011	BARRACKS	340	OPEN 24 HOURS
B-2	6557	BARRACKS	250	OPEN 24 HOURS
B-3	7306	BARRACKS	45	OPEN 24 HOURS
B-4	2607	BOQ	45	OPEN 24 HOURS
CS-1	1173	CHAPEL	150	7:00 A.M. TO 12:00 P.M. - WEEKDAYS 7:00 A.M. TO 12:00 P.M. - SUNDAY
CS-2	5007	CHAPEL	150	8:00 A.M. TO 4:30 P.M. - WEEKDAYS 8:00 A.M. TO 12:30 P.M. - SUNDAY
CS-3	4554	MUSEUM	8	10:00 A.M. TO 4:30 P.M. - WEEKDAYS
CS-4	.126	CAFETERIA	250	5:30 A.M. TO 7:30 P.M. - 7 DAYS A WEEK
CS-5	2320	POST EXCHANGE	50	7:30 A.M. TO 4:00 P.M. - WEEKDAYS
CS-6	1383	POST HOUSING ADMINISTRATION	29	7:00 A.M. TO 4:30 P.M. - WEEKDAYS
CS-7	7320	CERAMIC SHOP	4	9:00 A.M TO 2:00 P.M. - THRUSDAY
CS-8	1227	COMMUNICATIONS SYSTEM BLDG.	43	OPEN 24 HOURS
CS-9	850	GYMNASIUM	500	8:00 A.M. TO 9:00 P.M. - 7 DAYS A WEEK
CS-11	2385	BOWLING ALLEY	150	11:00 A.M. TO 11:00 P.M. - 7 DAYS A WEEK
CS-12	7060	THEATER	680	6:00 P.M. TO 11:00 P.M. - 7 DAYS A WEEK
CS-13	5223	FIRE STATION	6	OPEN 24 HOURS
CW-1	1198	COLD STORAGE WAREHOUSE	7	7:00 A.M. TO 4:00 P.M. - WEEKDAYS
D-1	5942	MESS HALL	300	4:00 A.M. TO 8:00 P.M. - 7 DAYS A WEEK
D-3	6723	MESS HALL	185	3:00 A.M. TO 8:00 P.M. - 7 DAYS A WEEK
FH-2	432	FAMILY HOUSING	4	OPEN 24 HOURS
FH-3	4408	FAMILY HOUSING	8	OPEN 24 HOURS
FH-4	7543	FAMILY HOUSING	4	OPEN 24 HOURS
FH-5	5683	FAMILY HOUSING	4	OPEN 24 HOURS
FH-6	1445	FAMILY HOUSING	8	OPEN 24 HOURS
FH-7	4634	FAMILY HOUSING	4	OPEN 24 HOURS
FH-8	5307	FAMILY HOUSING	4	OPEN 24 HOURS
FH-9	4101	FAMILY HOUSING	4	OPEN 24 HOURS
L-1	0018	LAUNDRY	70	8:00 A.M. TO 5:30 P.M. - WEEKDAYS
LAB-1	1068	ANIMAL HOLDING CENTER	6	7:00 A.M. TO 4:00 P.M. - WEEKDAYS
M-1	2000	DENTAL CLINIC	110	7:00 A.M. TO 5:00 P.M. WEEKDAYS
M-2	640	DISPENSARY	19	6:30 A.M. TO 3:00 P.M. - WEEKDAYS
MA-1	2783	INSTRUMENT & SMALL ARMS REPAIR	50	7:00 A.M. TO 4:00 P.M. - WEEKDAYS
MA-2	6117	TANK MAINTENANCE	35	7:00 A.M. TO 5:00 P.M. - WEEKDAYS

TABLE 3 (CONT'D)
BUILDING OCCUPANCY
FORT KNOX

GROUP NO.	BLDG.	BUILDING DESCRIPTION	NORMAL PEAK POPULATION	OCCUPANCY
MA-3	7374	MAINTENANCE	3	7:00 A.M. TO 3:30 P.M. - WEEKDAYS
S-1	5101	DATA PROCESSING & CHILDCARE	20	9:00 A.M. TO 3:30 P.M. - WEEKDAYS
T-1	6014	CLASSROOM & HEADQUARTERS	22	7:00 A.M. TO 5:30 P.M.
T-2	9298	CLASSROOM	25	7:00 A.M. TO 4:30 P.M. - WEEKDAYS
T-3	1543	VEHICLE TRAINING	45	8:00 A.M. TO 5:00 P.M.
U-1	7205	WASTE WATER TREATMENT	2	OPEN 24 HOURS
U-2	9009	WATER TREATMENT	2	OPEN 24 HOURS
U-3	4208	PUMPHOUSE	-	———
U-4	0017	BOILER PLANT	1	OPEN 24 HOURS
W-1	6569	CLOTHING & TEXTILE REPAIR	36	7:00 A.M. TO 4:00 P.M. - WEEKDAYS
W-2	2931	WAREHOUSE	-	ONLY WHEN SOMETHING IS BEING STORED OR MOVED
W-3	6570	WAREHOUSE	-	ONLY WHEN SOMETHING IS BEING STORED OR MOVED

TABLE 4

Building Group Source Energy Consumption

Group	Description	Group Sq. Ft.	Total Source Consumption 10^6 Btu's
A	Administrative	923,886	125,929
AH	Aircraft Hangar	138,142	13,144
B	Barracks	4,768,819	883,302
CS	Community Service	1,134,798	376,846
CW	Cold Warehouse	27,900	760
D	Dining	666,460	697,287
FH	Family Housing	6,172,958	1,639,255
L	Laundry	59,211	13,594
LA	Laboratory	204,331	29,793
M	Medical	680,555	93,452
MA	Maintenance	966,328	118,859
S	School	75,680	15,147
T	Training	985,842	112,556
U-1	Waste Water Treatment	2,889	23,780
U-2	Water Treatment	9,011	20,842
U-3	Pump Houses	5,984	75,072
U-4	Boiler and A/C Plant	50,763	2,825
W	Warehouses	843,217	199,658
X	No Utilities	497,422	
Z	Electric Only (Includes outdoor lights)	378,079	70,903

ENERGY CONSERVATION PROJECTS
SOURCE ENERGY SAVINGS

BUILDING TYPE	ENERGY SAVINGS BTUx1,000,000	% BASEWIDE REDUCTION FY'75	PROJECT NUMBER
FAMILY HOUSING	192,116 103,559 295,675	4.56 2.46 7.02	T-65000 T-67100
HOSPITAL CHILLER REPLACEMENT	15,439	.37	
BARRACKS	9,744 66,909 735 15,370 51,296 144,054	.23 1.59 .02 .37 1.22 3.43	T-65200 T-66900 T-68400 T-68300 T-68600
STEAM PLANTS	9,899 31,024 40,923	.24 .74 .98	T-67300 T-68500
SELECTIVE ENERGY PLANT	60,000	1.43	
OTHER BUILDINGS AFFECTED BY ECIP'S	26,230 5,960 18,315 46,496 29,666 99,875 226,542	.62 .14 .44 1.10 .70 2.37 5.37	T-65200 T-65100 T-66800 T-66900 T-68400 T-68300
TOTAL	782,633	18.60	

TABLE 5

FK

ENERGY CONSERVATION PROJECTS DEVELOPED SCHEDULE - FT. KNOX, KENTUCKY

PROJECT TITLE	PROJECT NUMBER	RECOMMENDED FISCAL YEAR	COST $ x 1000	E/C RATIO	ENERGY SAVINGS BTUx10^6	YEARS PAYBACK	B/C RATIO
STORM WINDOWS, WEATHERSTRIP DOORS, AND KITCHEN LIGHTING FIXTURE IN FAMILY HOUSING	T-65000	1980	4073	49.7	192,116	10.55	1.78
POWER FACTOR IMPROVEMENT	T-65100	1980	121	49.2	5,960	13.55	1.26
REDUCTION OF BASEWIDE FLUORESCENT LIGHTING LOAD	T-65200	1980	553	65.0	35,974	4.20	1.93
TOTAL			4747		234,050		
ADJUST FRESH AIR QUANTITIES	T-66900	1981	169	670.0	113,405	.56	33.10
FAMILY HOUSING EQUIPMENT MODIFICATIONS	T-67100	1981	1203	90.7	103,559	5.22	3.64
INSTALLATION OF CEILING FANS IN HIGH BAY AREA BUILDINGS	T-66800	1981	176	104.2	18,315	1.90	9.99
STEAM PLANT MODIFICATIONS	T-67300	1981	229	43.3	9,899	4.69	4.26
TOTAL			1777		245,178		
EMCS EXTENSION	T-68300	1982	1411	81.7	115,245	5.40	2.34
TEMPORARY BUILDINGS IMPROVEMENTS	T-68400	1982	604	50.3	30,401	8.64	2.20
CONSOLIDATION OF HEATING PLANTS, ST. JOHN TANK/MOTOR PARK	T-68500	1982	776	40.0	31,024	8.77	2.11
PERMANENT BARRACKS HEATING SYSTEM IMPROVEMENTS	T-68600	1982	2557	20.1	51,296	8.56	2.23
HOSPITAL CHILLER REPLACEMENT		1982	623	24.8	15,439	7.14	2.66
TOTAL			5971		243,405		
SELECTIVE ENERGY PLANT		1983	69230	N/A	60,000	2.3	1.08
TOTAL			69230		60,000		

TABLE 6

APPENDIX B

POTENTIAL CONSERVATION MEASURES

TABLE OF CONTENTS

POTENTIAL CONSERVATION MEASURES REQUIRING CAPITAL INVESTMENT

	Project Studied	Comments
1.	Install vestibules around high traffic doors.	This project has limited application. The calculations are subject to numerous assumptions.
2.	Install solar shading devices: • Solar film • Solar screens • Overhangs • Awnings	Insulating solar film would be cost effective, however, it would possibly be subject to damage by vandalism.
3.	Install attic ventilation fans.	This project does not meet the criteria.
4.	Install whole-house attic fans.	The savings are too occupant-dependent.
5.	Reset outside air dampers to minimum requirements of ASHRAE 62-73.	Good project
6.	Install boiler economizers, oxygen trim controls, blowdown heat reclaim devices, etc.	Good project
7.	Install storm windows.	Good project
8.	Weatherstrip doors.	Good project
9.	Add floor, ceiling, and wall insulation.	This is a viable project if there is no insulation present. The walls, however, do not meet the criteria.
10.	Install setback/setup controls.	Good project
11.	Add warmup cycle with fresh air dampers closed where setback/setup controls are used.	Good project

POTENTIAL CONSERVATION MEASURES REQUIRING CAPITAL INVESTMENT
(Continued)

	Project Studied	Comments
12.	Install flue dampers, smaller jets, dual burners, electronic ignition, etc. in small furnaces.	Flue dampers, dual burners and electronic ignition do not meet the criteria.
13.	Replace manual control valves or install temperature regulators in cast-iron radiators.	Good project
14.	Replace existing coal boilers with gas/oil conversion kits with modern packaged boilers.	This project does not meet the criteria.
15.	Replace incandescent lighting with higher efficiency lighting systems.	Good project
16.	Install photocell lighting controls.	This project has limited application.
17.	Replace existing motors with motors of the high efficiency type.	There is an engineering disagreement concerning this project.
18.	Reduce lighting levels to minimum standards.	Good project
19.	Install water closet tank inserts, flow reducing shower heads, or other water conserving devices to reduce pumping energy consumption.	Good projects
20.	Insulate existing steam lines.	This project does not meet the criteria.
21.	Revise existing chilled water/ hot water pumping schemes to more efficient methods.	N/A

POTENTIAL CONSERVATION MEASURES REQUIRING CAPITAL INVESTMENT
(Continued)

	Project Studied	Comments
22.	Deactivate individual room thermostats in barracks and install temperature reset controls on chilled and hot water.	Good project
23.	Shut down steam plants in the summer and satisfy process steam needs with electric boilers.	Good project
24.	Install infrared heating in warehouses, hangars, and shops.	This is a viable project, however, new natural gas hookups are prohibited.
25.	Install economizer systems for "free cooling" in intermediate seasons.	This project does not meet the criteria in retrofit applications.
26.	Modify multizone systems to include hot/cold deck reset.	Good project
27.	Modify cooling tower systems to cycle fan with load and/or install bypass valving.	Condenser water reset is the best modification.
28.	Install load-shedding system to minimize demand charges.	Good project
29.	Correct power factor.	This project does not meet the criteria.
30.	Install chilled and hot water reset controls.	Good project
31.	Install FM radio control system.	Good project
32.	Replace existing windows with insulating panels.	Good project
33.	Insulate temporary buildings.	Good project

POTENTIAL CONSERVATION MEASURES REQUIRING CAPITAL INVESTMENT
(Continued)

	Project Studied	Comments
34.	Upgrade electrical distribution voltage.	This project does not meet the criteria.
35.	Install total or selective energy plants.	Selective energy is borderline cost effective.
36.	Install energy monitoring and control system.	Good project
37.	Install heat reclaim devices on air-cooled condensers.	This project is viable in messhalls and family housing.
38.	Replace remotely located absorption chillers with more efficient electric-driven chillers.	Good project
39.	Install solid waste-burning boilers.	Good project
40.	Install trailer enclosing devices at loading docks.	This project has limited application.
41.	Install solar energy systems where feasible.	This project has limited application.
42.	Install air-to-air heat reclaim devices in high exhaust areas, such as messhall kitchens.	This project does not meet the criteria.

POTENTIAL CONSERVATION MEASURES REQUIRING POLICY CHANGES AT INSTALLATION LEVEL

	Project Studied	Comments
1.	Replace domestic water heaters with higher efficiency models as replacement is required.	Good project
2.	Shut down steam branch lines in summer.	Good project
3.	Reduce domestic hot water temperatures from 140 F to 110-120 F.	Good project
4.	Replace electric motors with motors of the high efficiency type on replacement basis.	Good project
5.	Use task lighting.	Good project
6.	Install temporary 4-mil plastic storm windows.	Good project
7.	Shut down HVAC and DHW systems in unoccupied buildings.	Good project
8.	Calk cracks on self-help basis.	Good project
9.	Install high-efficiency transformers on replacement basis.	Good project
10.	Enforce indoor space temperature regulations.	Good project
11.	Repair steam, condensate, chilled water, and HTHW leaks.	Good project
12.	Repair air leakage in ducts.	Good project
13.	Turn pilot lights for heating equipment off for the summer.	Good project
14.	Replace air-conditioning units with high efficiency models as replacement is required.	Good project